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ABSTRACT

The possibility that a specific engineering curriculum reduces the creative potential of its students was investigated, along with the relationship between pre-cognition, the ability to foresee events, and creativity. Engineering freshmen and seniors were tested and compared on creative potential. Liberal arts freshmen and seniors were also tested and used as a control. The Torrance Figural B Creativity Test was used to measure creativity; the Dean-Mihalasky test was used to measure pre-cognition. Results indicate that contemporary engineering education has no effect on the creativity of students, since freshmen and senior engineering students had the same creativity index. The creativity of engineers, on the dimension of originality, was significantly higher than the liberal arts group. Some strong correlations and patterns are shown between creativity and pre-cognition. The main conclusion is that the four-year undergraduate education at the University of New Haven did nothing to increase the student's creative propensity; if anything, the student's creative potential was decreased. The proposition that creativity and pre-cognition are related is somewhat supported by statistical evidence, but the relationship is not consistent. It is suggested that the successful development of the creative ability of students depends on a university-wide commitment to creativity as an objective of the institution. Appendices include IQ-to-creativity correlations and creativity and pre-cognition scores. (Author/LBH)

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THE EFFECT OF CONTEMPORARY ENGINEERING EDUCATION ON THE CREATIVE POTENTIAL OF ENGINEERING STUDENTS

BY

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1977

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ABSTRACT

The Effect of Contemporary Engineering Education on The Creative Potential of Engineering Students

F. J. Costello
1977

The purpose of this study was to determine whether or not a specific engineering curriculum reduces the creative potential of its students. A collateral purpose was to explore the relationship between pre-cognition, the ability to foresee events, and creativity.

Engineering freshmen and seniors were tested and compared on creative potential. Liberal Arts freshmen and seniors were also tested and used as a comparative control. The Torrance Figural B Creativity test was used to measure creativity.

Subjects were tested for pre-cognitive ability. The Dean-Mihalasky test was used to measure pre-cognition.

Experimental methods and analysis conformed to research procedures according to B. Tuckman's Conducting Educational Research, Harcourt Brace Jovanovich, 1972.

Results indicate that contempory engineering education has no effect on the creativity of students. Freshmen and senior engineers had the same creativity index. The creativity of engineers, on the

dimension of originality, was significantly higher than the liberal arts group.

Some strong correlations and patterns developed between creativity and pre-cognition.

The main conclusion was that the four year undergraduate education at the University of New Haven did nothing to increase the student's creative propensity. If anything, the student's creative potential was decreased.

The proposition that creativity and pre-cognition are related is somewhat supported by statistical evidence. However, the relationship is not consistent. Other forces, unknown as to their nature, apparently cause the relationship to, at times, weaken.

The successful development of the creative ability of students depends on a University wide commitment to creativity as an objective of the institution. Too much emphasis is placed on preparing the student for a job, consequently the educational process concentrates on filling the student with information. Little time is devoted to training the student's mind.

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INTRODUCTION

CONTEXT OF THE PROBLEM

In our age of mediocracy, unconcern, conformity and disregard for the human culture, man, with anxiety, waits for the creator.

Modern technology, analytical processes, and computers, via the corporate state, assume the task of straight line logical reasoning, and society increasingly rewards the non-logical uncreative process of thought.

Now, with greater urgency than ever before, society requires the creative thinker. However, colleges and universities intensify the production of the type of product that society will reward. Education, divorced from the corporate requirement, must concentrate on the stimulation of the creative process. (1)

To a large extent, engineers are responsible for the way we live today and the way we will live tomorrow. Yet, engineers are not regarded as creative people. A common complaint is that engineers solve problems with mastery of technique as learned in school, but are helpless to solve problems where new paths are demanded. (2)

Ninety to ninety-five percent of engineering students never become creatively productive. Forty to sixty percent of engineering

students drop out, while the engineering educational process destroys the creative potential of those students who survive. There is speculation that the drop outs include a major share of students who have high creative potential. (3)

If engineering education weeds out creative students or destroys the creative potential of the graduate, it may be due to the curriculum or the delivery system. If this is so, what can be done to reverse this apparently undesirable effect?

STATEMENT OF THE PROBLEM

This study addresses the following questions:

1) What is the relationship between the creativity of senior engineering students and the creativity of freshmen engineering students?

2) What is the relationship between the creativity of senior liberal arts students and the creativity of freshmen liberal arts students?

3) Is the creativity of engineering freshmen the same as the creativity of liberal arts freshmen?

4) Is the creativity of liberal arts seniors greater than the creativity of engineering seniors?

5) Is pre-cognition, a person's ability to foresee events, related to creativity?

REVIEW OF THE LITERATURE

CREATIVITY

There are several schools of thought relative to creativity. Each school centers its research and evaluation around a theory that describes the creative process and the creative product. In the psychoanalytic approach, pioneered by Freud, creativity is regarded as a process that is inherent in the individual, but largely beyond the individual's control. (4) (5)

The proponents of self-actualization as a pre-condition for creativity form another school of thought. As proposed by Carl Rogers, the pressure of society on the individual to conform forces the individual to develop a complex system of defense mechanisms that obliterate the individual's creativity. (6) According to this approach, as the individual's need for social acceptance declines, his propensity to create increases. (7)

A series of studies between 1950 and 1954 by Roe suggested that personality differences account for the variation in the creative output of people. The study analyzed the personality of scientists who had made original contributions in their respective fields. One of the

conclusions was that creative people are of fairly high intelligence coupled with a very high degree of persistence and motivation, independence of mind, and a high degree of self-sufficiency. The findings of Roe seem to support the self-actualization point of view. (8) (9)

Closely related to the self-actualization approach, the environmentalist school recognizes that creative ability is inhibited by forces external to the individual. However, they believe that creativity in an individual can be activated by the systematic reinforcement of specific behaviors. In other words, people can learn to be creative. (10) In support of the environmental approach, research indicates that creative children come from homes that maintain a creative environment. (11)

The associative theory suggests that creativity is the process of combining elements of thought that were previously distant from each other. It suggests that creativity manifests itself when problems are solved via the association of ideas that were not previously recognized as being related to each other. When presented with a stimulus, the vast majority of individuals will provide a series of common responses while the creative person responds with a mixture of common responses and rare responses. (12)

Creativity as an outcome of the organization and degree of one's intellect is sponsored by the factorial view. The theory maintains that there are at least 120 factors of intellectual ability. An individual with a particular organization and quality of intellectual factors has the creative trait. Furthermore, these factors can be specified and isolated via measurement, according to the proponents of factorialism. (13)(14) The factorial view tends to fragment the concept of creativity and intelligence, and little is offered relative to the association of the fragments into an apparently intelligent behavior. Most psychologists regard the factorial view as subordinate to the concept that creativity and intelligence exist as broad but identifiable traits. (15)

The study of creativity is in its infancy. Consequently, the identification of the creative individual, agreement as to the nature of the creative process and, a clear view of the characteristics of the product of creativity are still under debate and investigation. Prior to 1950, very little work had been done. Between 1945 and 1968, out of 121,000 titles listed in the Psychological Abstracts, only 186 could be related to creativity, imagination, originality, thinking, or to tests relating to these categories. (16) However, since 1950, the inertia associated with the study of creativity has been overcome. Many new

studies have opened new avenues of research, and the phenomenon of scientific curiosity is beginning to function.

CREATIVITY, INTELLIGENCE AND COLLEGE GRADES

Over the past 10 or 12 years there have been numerous studies conducted in an effort to determine whether or not intelligence and creativity are related.

Investigations in 1962 by Getzels and Jackson compared scholastic achievement of two groups of students. One group was made up of high IQ, but low creativity students. The second group was composed of high creativity, but low IQ students. (17)

However, all of the students used by Getzels and Jackson had IQ scores of over 130. The "low" IQ group was only relatively low.

Getzels and Jackson found that the highly creative group came from less "academic" families, had non-conformist attitudes, and tended to be more motivated when compared to the low creativity group.

There were no measurable differences in achievement between the two groups. Correlations of creativity tests and IQ scores provided an indication that creativity and intelligence were independent characteristics.

Further analysis of Getzels and Jackson's experimental data by other investigators yielded no indication that creativity and intelli-

were separate traits. (18)

Again, in 1965, Edwards and Tyler, operating on the Getzels and Jackson hypothesis, performed similar experiments and concluded that there was no relationship between creativity and intelligence. (19)

Studies which were similar to those of Getzels and Jackson were conducted by Torrance. They also showed no significant difference in achievement between high IQ students and high creativity students. (20)

In 1962, experiments by Cline showed that a combination of high intelligence and high creativity produced in students a significantly higher academic achievement than that produced by high intelligence or high creative ability alone. (21)

More recently, in 1972, Stallings and Gillmore, in studies conducted at the University of Illinois, found that creativity, as measured by the Torrance figural tests, and course grades in a college of arts and science, did not correlate. (22)

Follman conducted investigations in 1973 on the relationship between IQ and creativity and came to the conclusion that IQ had a very limited influence on creativity. He used the Lorge-Thorndike IQ and the Torrance creativity tests. (23)

Typical correlation coefficients, obtained by various investigators,

relating IQ to creativity are given in Table 1.

TABLE 1 Typical correlation coefficients relating IQ to creativity.

Subjects	Correlations
Elementary Students	.16
High School Students	.30
College Students	.16
Graduate Students	.10
Engineers	.15
Architects	-.08
Scientists	-.07

The general opinion at this time is that creativity is somewhat independent of intelligence, and the two characteristics, upon measurement and analysis, seem to mesh or overlap to an extent that depends on the IQ level. Experiments that show creativity and intelligence to be distinct and unrelated involved the use of high IQ subjects.

There is some experimental evidence that the relationship between creativity and intelligence decreased as the degree of intelligence increased. Yamamoto, using large samples of elementary school students, found that correlations between creativity and IQ fell

as the IQ level increased. (24)

CREATIVITY AND ENGINEERS

There has been very little research in the field of creativity that directly relates to engineers or engineering students.

Taylor did some work with engineers. He ran correlations on the creativity and intelligence of engineers and found correlations of from .07 to .2. (2)

Also, MacKinnon's work with architects and scientists related creativity to intelligence. His work yielded correlations of -.07 for architects and -.08 for scientists. (2)

It may be safe to presume that the intelligence of engineers, architects and scientists is rather high. The low correlations obtained by Taylor and MacKinnon (above) may be based on the Yamamoto effect, that the correlation between intelligence and creativity decreases as intelligence increases.

Some interesting work was done by Freeman and McComisky with architectural students. Their investigation utilized the "Abstract-Concrete" performance tests developed by McComisky at Hull University. The McComisky test measures the ability of subjects to assemble an assortment of blocks of various size and shape into organizations.

A portion of the test, involving divergent thinking, allows the subject to decide for himself the nature or type of organization the blocks may take. The second portion of the test involves an instruction to the subject as to what form the organization should take. This portion of the test involves convergent thinking.

A liberal arts control group was used in addition to the experimental group of architectural students. Results indicate that the architectual students performed significantly better than liberal arts groups on both the divergent and convergent portions of the test.

Also, the tests successfully predicted the degree of success of the students in their course work.

Divergent and convergent thinking is regarded as a facet of creative ability. The authors suggested that similar results may be obtained with engineering students. However, the test that was used, the McComisky test, is compatible with the nature of instruction in architectual curriculums and is foreign to liberal arts students. Moreover, small sample sizes were used throughout the Freeman and McComisky experiments. (25)

The effect of an engineering curriculum on the creative student was studied by Snyder in 1967. He worked with over 700 engineering

freshmen at the Massachusetts Institute of Technology. Snuder points out that the engineering curriculum does not allow for intellectual risk-taking on the part of the student. The engineering training does not allow for closure by letting the student choose or select one of a number of approaches to a problem.

Snyder concluded that the nature of the engineering curriculum at MIT was responsible for 2/3rds of the total loss of students in the freshmen class.

CREATIVITY AND PRE-COGNITION

The May 1972 issue of Iron Age reports on research in extra-sensory perception as a "deadly serious business of building more creativity into the engineers who create our future". Pre-cognition, an aspect of extra-sensory perception, is a person's ability to forcast future events.

The phenomena of intuition and pre-cognition have been linked experimentally by Mihalasky and Dean at the New Jersey Institute of Technology. (27) There, studies that are based on the laws of probability, show that successful executives who often make correct decisions based on intuition when data and facts dictate a contrary decision, score above

average on pre-cognitive ability.

Intuition was linked to creativity by Barron and Kantor. They reported that a cardinal trait of creative people is intuition. (28)

Unpublished data recorded by Mihalasky single out engineers as having poor pre-cognitive ability. The writer, based on studies made at the University of New Haven's School of Engineering, confirmed Mihalasky's results. Engineers score below what is expected by chance alone on tests that measure their ability to forecast future events.

Using the results of investigations described above, we may say that intuition, creativity and pre-cognition are linked, and since engineers have poor pre-cognitive ability, they may be expected to be a relatively non-creative group.

Only a few studies have investigated the relationship of pre-cognition and creativity. Schmeidler did some research in the area. Her results were inconclusive, but led her to speculate that the more creative person may be more responsive to pre-cogitive ability. (29)

In 1967, Mihalasky tested 41 corporate executives for pre-cognition and creativity. He used the Torrance "Class of Use" test to obtain a creativity score, and the 100 digit test to measure pre-cognition. The 100 digit test, devised by Dean and Mihalasky, compares a 100

digit number, forecasted by the subject, to a 100 digit number produced by a random number generator. The two numbers are compared, digit to digit. The number of times the subject accurately predicts a digit in the random number is the subject's pre-cognitive score.

The analysis involved a breakdown of data based on the Schmeidler test for dynamic personalities which was also administered. The breakdown divided the test group into two categories, non-dynamics and dynamics.

The results of this experiment were statistically insignificant; no relationship between pre-cognition and creativity was established.(27)

Charles Honorton reported on pre-cognition and creativity based on studies performed at the Marmonides Parapsychology Laboratory. He found that those subjects who scored high on creativity, also scored high in pre-cognitive ability. (30) Honorton used portions of the Torrance tests of creative thinking to produce a creativity index for each of 26 junior high school students. The creativity indexes were correlated to pre-cognition scores that were obtained via the 100 digit test. A correlation of .79 was obtained between pre-cognition and creativity. Torrance regarded the results of the experiment as an indication of the construct validity of his creativity test. (31)

There is very little experimental evidence available upon which a hypothesis relating pre-cognition and creativity can be supported.

ENGINEERING EDUCATION

Lawrence S. Kubie, in 1965, referred to engineering education as a universal, concealed, neurotic process, and regarded the condition as a matter of urgent concern. (32) The main concern is weakness in the engineering student's productivity subsequent to graduation. Kubie notes that the creative output of students in all fields, after graduation, is low, but relative to engineering, the problem is of further importance because of the high cost of engineering education and its practical importance to the community.

Many writers have stressed flexibility and freedom as pre-requisites to the development of creativity in the student. Engineering education, in the classroom and laboratory, offers little freedom or flexibility. Techniques in Strength of Materials are precise and the entire class works on the same homework and the same lab experiments. (33)

Moreover, conforming behavior by the engineering student relative to the precise and accepted method of analysis is rewarded by a grading system that, conversely, punishes the creative approach. (34)

Since engineers teach engineers, the uncreative process of engineering education has a tendency of perpetuating itself.

Simons suggests that students can be trained in creativity only through intimate contact with mature people of demonstrated creative ability. (35) However, engineering teachers are selected on the basis of academic excellence or high grades in college and an extensive exposure to the conventional engineering education system. Yet, high grades and high intelligence are not necessarily prerequisites for high creativity. (36)

The creative process requires an immersion into the subject matter. It is referred to as the period of preparation. Engineers go through this immersion and preparation via engineering education. However, the immersion process strongly conditions the student to ideas that are current in the field. These ideas become knowledge, and it is recognized that knowledge, even though it is necessary, works against creative thinking. (37) This is a paradox of the creative process and it applies to engineering education.

SUMMARY-SIGNIFICANCE

There are few research results that pertain to the creativity of engineering students. Nothing could be found that relates creativity to

"before" and "after", with the engineering curriculum as an independent variable. Also, no research results could be found that compare the creativity of engineering students to that of liberal arts students.

Some work has been done on the relationship between creativity and pre-cognition, but the results are not conclusive.

Therefore, the results of the current research will add to the literature of creativity and pre-cognition in areas where research has been minimal.

Moreover, society depends on engineers to create the environment that we must live in via an efficient and imaginative utilization of the natural resources.

Therefore, the effect of contemporary engineering education on the creativity of students is of vital concern to the community and of professional interest to engineering educators.

The primary objective of this study is to determine the effect of engineering education on the creativity of students; however, other investigators may become involved via subsequent research in an effort to improve the student's creativity by curriculum and delivery innovations.

STATEMENT OF THE HYPOTHESES

HYPOTHESIS 1:

The creativity index of senior engineering students is lower than the creativity index of freshmen engineering students.

HYPOTHESIS 2:

The creativity index of liberal arts freshmen is lower than the creativity index of liberal arts seniors.

HYPOTHESIS 3:

The creativity index of engineering freshmen is the same as the creativity index of liberal arts freshmen.

HYPOTHESIS 3A:

The creativity of liberal arts seniors is greater than the creativity of engineering seniors.

HYPOTHESIS 4:

Drop outs from the engineering programs have a higher creativity index than engineering seniors.

HYPOTHESIS 5:

The pre-cognitive ability of students is an indicator of their creative ability.

RATIONALE FOR THE HYPOTHESES

Hypothesis 1:

Senior engineering students display less creative ability than engineering freshmen.

The logical justification for this hypothesis rests on the proposition that the absorbtion of a discipline, with its current and rigid views, will lower creative expression. The engineering curriculum is a very rigid and dogmatic experience.

Hypothesis 2:

The liberal arts curriculum increases the creative potential of students.

The purpose of a liberal arts program is to expand the student's perspective on life and the society. Freedom of express is characteristic of liberal arts programs. The broadening effect, and the absence of a rigid curriculum is expected to increase the student's creative ability.

Hypothesis 3:

Engineering and liberal arts freshmen have equal creative ability.

A study of the socio-economic characteristics of the entire student body at the University of New Haven showed that the engineering student was a typical student when compared to the average university

student. (38) Moreover, the grade school and high school experience is rather uniformly applied to all students; curriculums differ sharply only at the college level. Consequently, we may expect liberal arts freshmen to display approximately the same creative ability as engineering freshmen.

Hypothesis 3A:

Liberal arts seniors have a greater creative ability than engineering seniors.

If the premise that engineering education lowers creativity while the liberal arts education increases creativity is true, and the hypothesis that engineering and liberal arts freshmen have the same creative potential is true, it seems reasonable to expect liberal arts seniors to have a creative potential that is higher than engineering seniors.

Hypothesis 4:

Drop outs from the engineering curriculum are more creative than the students who survive the engineering school training.

L. S. Kubie (32) reports on a conversation with the Dean of a major engineering school (unidentified) where the conclusion of the discussion was the proposition that engineering school drop outs included the major portion of high creativity students in the engineering

program. The report was made in 1967. A search did not produce any hard evidence relative to the proposition.

Hypothesis 5:

The pre-cognitive ability of students is an indicator of their creative ability.

The relation between pre-cognition and creativity is unclear. Schmeidler's research produced mixed results while Honorton's work produced a correlation of .79.

Conversations with pre-cognition researchers at the New Jersey Institute of Technology indicate a logical association between creative and pre-cognitive ability, but research relative to the question is not conclusive.

OPERATIONAL DEFINITIONS

CREATIVE ABILITY

Creative ability as used in this study is indicated by the score that the student receives upon testing. The test is the Torrance Figural B, and the tests were scored via the Torrance scoring guide.

There are many definitions of creative ability. Torrance suggests the following: Creativity is a process of becoming sensitive to problems, deficiences, gaps in knowledge, missing elements, disharmonies, and so on; identifying the difficulty, searching for solutions, making guesses, or formulating hypotheses about the deficiencies; testing and re-testing these hypotheses and possibly modifying and re-testing them; and finally communicating the results.

The definition implies a positive relationship between creativity and pre-cognition.

PRE-COGNITION

In this study, pre-cognition refers to a person's ability to forecast events without the benefit of data, and under test conditions that eliminate the usefulness of experience.

ENGINEERING FRESHMEN AND SENIOR STUDENTS

A freshman engineering student, in this study, is a student registered in any one of the four engineering programs at the University of New Haven's School of Engineering, who has earned not more than 30 credits towards the bachelor's degree in engineering. He is a day student.

A senior engineering student is the same as a freshman, with the exception that he has earned at least 100 credits toward his bachelor's degree.

Engineers who have earned a degree were not used in this research.

ENGINEERING DROP OUTS

An engineering drop out is a day student in any curriculum at the University of New Haven other than the engineering curriculum, who had been registered in one of the engineering programs, but either failed or withdrew from engineering. The student may be at any point in the new curriculum, from freshman to senior status.

LIBERAL ARTS FRESHMEN AND SENIOR STUDENTS

A liberal arts freshman student is a registered day student with

not more than 30 credits in any of the following bachelor's degree programs at the University of New Haven:

English	Biology	Psychology
Philosophy	Fine Arts	Mathematics
History	Music	Social Services
Chemistry	Sociology	Languages

A liberal arts senior is the same as a freshman, but with earned credits of at least 90 semester hours.

METHODS AND PROCEDURES

SUBJECTS

The engineering students used as subjects in this study were freshmen and seniors attending the day engineering school at the University of New Haven.

Senior day engineering students are exclusively male, between the age of 21 and 26, and they usually come from surrounding towns (85%) since the University of New Haven is a commuter-type school. (38) A senior student is defined as one who has earned at least 100 credits toward his bachelor's degree.

Freshmen engineering students, while a bit younger, are similar to the senior students. Students with less than 30 credits were regarded as freshmen.

A sample of 40 senior engineers and 36 freshmen engineers was selected and tested by identifying certain classes that contained the desired type of subjects, and devoting a particular class session to data taking. It took about 45 minutes to get the required data. As a supplement to the data obtained via classroom tests, some engineering students were approached during registration procedures and asked to take the tests on an individual basis.

Liberal arts students attending the day college at the University of New Haven were used as a control or comparison group. Both freshmen and senior liberal arts students were tested for creativity and pre-cognition. The method of selecting the students was identical to the method used to select engineering students. The group was composed of both male and female students of approximately equal age and background. A sample of 38 freshmen and 36 seniors was tested.

INDEPENDENT VARIABLES

The main theme of this study is the creativity of engineering students, and the independent variable is the engineering curriculum. Engineering education involves a four year period. During that period, intervening variables relating to the student's change from adolescence to adulthood could have an effect on the student's outlook and perspective that may in turn affect creativity.

However, it was assumed that the major influence on the student's discipline and rigidity was the rigorous engineering curriculum.

The engineering curriculum at the University of New Haven is a rather typical program that conforms to guidelines established by the Engineer's Council on Professional Development. Total credits required for the bachelor's degree average about 130 credit hours.

A general breakdown of the required credits for the degree is:

Mathematics, Physics, Chemistry	33 credits
Engineering Science	30 credits
Engineering Major	45 credits
Humanities	21 credits

DEPENDENT VARIABLE

Creativity, the dependent variable was measured by the Torrance Test for Creative Thinking, Figural "B". The Figural "B" involves a pictorial response by the subject to three activities; picture construction, picture completion, and circle completion. Each activity is scored for fluency, flexability, originality and elaboration.

The test was administered according to the instructions by Torrance published in the Figural Test Booklet B that is supplied with the purchase of the test forms. Also, the booklet provides instruction for scoring the test.

PRE-COGNITION

Pre-cognition may be regarded as a dependent or independent variable as it is correlated to creativity.

The Dean test for pre-cognition has been used in this study to

measure the ability of the subjects to forecast future events. For a description and discussion of this test, see page 28 .

THE TORRANCE CREATIVITY TEST

RELIABILITY

Test-retest reliability of the Torrance test has been established by several investigators other than the author of the test. A table is presented below that summarizes the test-retest correlation coefficients obtained by three investigators.

Investigators	Year	Correlation
Woodthe (39)	1963	.88
Goralski (40)	1964	.75
Hagender (41)	1967	.85

Inter-scorer reliability was established by Torrance and results are published in the Torrance Technical Manual. He found that classroom teachers who studied the scoring instructions, graded the tests essentially the same as trained graders. Correlations between classroom teacher's scores and the scores produced by the trained graders varied from .96 to .88.

VALIDITY

The content validity of the Torrance test is based on, in the words of Torrance, "a consistent and deliberate effort to base the test stimuli, the test task, instructions and scoring procedures, on the very best theory and research now available."

Thorndike has criticized the validity of the Torrance test. A rebuttal by Torrance is available from the Personal Press, and can be found in the Norms-Technical Manual for the Torrance Creativity Tests.

Construct validity has been checked by several researchers. Fleming and Weintraub (42), in 1962, correlated measures of rigidity and results from the Torrance creativity test. The results showed the predicted negative correlation since rigidity is inversely related to creativity. Fleming reported a correlation of -.4.

In 1963, Yamamoto related results obtained using the Torrance creativity test and the analysis of imaginative stories of grade school students. He reported a positive correlation of .51. (43)

PRE-COGNITION-DEAN TEST

Pre-cognition has been included in this study in an effort to establish its relation to creativity. Several researchers have conducted similar studies with mixed results.

The test that was used to measure pre-cognition is the Dean number guessing test developed at the New Jersey Institute of Technology.

The Dean test for pre-cognition evaluates a person's ability to guess a number that is subsequently produced by a computer's random generator. The number contains 100 digits. By chance alone, the subject should produce, on the average, 10 correct guesses. Those who do better than what might be expected by chance alone are considered to have a pre-cognitive "ability". The number of correct "guesses" is used as the pre-cognition score.

VALIDITY

Any test to measure pre-cognition must eliminate all possible connections between the subject's five senses and the future event he is to predict. Moreover, all past experience of the subject must be designed out of the test in order to eliminate the "educated" guess. If the test neutralizes the five senses and eliminates the advantage of past experience, then the test may be truly measuring the subject's ability to describe a future event that is totally unavailable to his conscious senses and past experience.

The Dean test involves the forecast of a 100 digit random number. The 100 digit random number is produced, subsequent to the subject's

prediction, via a computer's random number generator that is guaranteed to produce a number whose digits are as equally likely to appear as any other digits. The random number is triggered by a "seed" number that is itself a random number. Both the seed and the randum number produced by the computer are totally unavailable to the subject.

Under the above circumstances, the test cannot possibly do anything other than measure the subject's ability to predict an event that is totally unpredictable except by pure guess alone, unless there is an unknown force influencing the subject. The unknown force may be extra-sensory perception, and pre-cognition is regarded as an extra-sensory ability.

The validity of the Dean test can only be established through construct validity procedures. This study is expected to contribute to the construct validity of the test.

RELIABILITY

The reliability of the Dean test for pre-cognition, for several reasons, cannot, with reasonable convenience, be checked by test-retest procedures.

Pre-cognition has a fading effect. (27) If a subject is tested and re-tested, performance deteriorates to a chance condition and the

advantage offered by any pre-cognitive ability is lost. It has been shown by Mihalasky and Dean that clairvoyance also fades on retests, but tends to recover. (44) This phenomenon is referred to as the "U" effect.

Also, time enters into the experiment. The subject's performance may vary when testing is done over intervals of time. (45)

The ability of the Dean-Mihalasky pre-cognition test to consistently measure a pre-cognitive effect was demonstrated by Mihalasky in a series of experiments from 1965 to 1968. The results of the experiments are reported in Executive ESP. (27)

Mihalasky's experiments involved the testing of 22 different groups of people for pre-cognition via a single 100 digit test per subject. In conjunction with the pre-cognition test, Mihalasky administered an "attitude toward time" test that was developed by Dr. Schmeidler. (46) The Schmeidler test separates people into one of two classifications, dynamic or non-dynamic. Pre-cognitive test results were separated into a dynamic and a non-dynamic group via the Schmeidler test.

Since the test for pre-cognition involves 100 tries at guessing a single digit that can be at random, any digit from zero to nine, the expected results, by chance alone, is 10 correct guesses. However, Mihalasky found that dynamic people, as groups, consistently scored

better than 10, the chance expectation, while the non-dynamic group consistently scored below the probablistic mean of 10. If the Dean test was not a reliable measure of pre-cognition, the scores of the dynamic groups might be expected to wander above and below the chance expectation of 10. This is also true for the non-dynamic groups. Such was not the case.

Also, the construct validity of the Dean pre-cognitive test seems to be supported by the results of the experiments.

Mihalasky's test results could have been produced by chance alone, but the calculated probability of such a chance occurrance is on the order of one chance in one million, which is a most unlikely event. (27)

Therefore, it can inferred, by the weight of overwhelming mathematical odds, that the Dean-Mihalasky pre-cognition test consistently measures the pre-cognitive effect.

DATA COLLECTION

The Torrance creativity test and the Dean-Mihalasky pre-cognitive test was administered to:

Group A:	40 engineering seniors
Group B:	36 engineering freshmen
Group C:	36 liberal arts seniors

Group D: 38 liberal arts freshmen

Group E: 11 engineering drop outs

Subject groups were tested during the fall and spring semesters of the 1976 - 1977 academic year at the University of New Haven.

The administration and scoring of the Torrance creativity test was done according to the instruction guide published by the Personel Press, entitled Directions Manual and Scoring Guide - 1974 Edition.

The pre-cognitive test, a form with one hundred boxes, each to contain a single digit of the subject's forecast, was administered with the creativity test. The student was instructed to insert his selection of digits at random, as they occurred to him. Subsequently, a computerized random number generator was used to produce the 100 digit number to which the subject's prediction was matched. The number of correct or matched digits is the subject's score.

The student was not asked to identify himself since a freely creative response on the creativity test could be inhibited if the student knew that he could be personally identified to the response. Therefore, causal factors such as sex, high school record and nationality, were lost in an effort to obtain true indications of creativity.

DATA ANALYSIS

Hypothesis 1) $O_1 \ X_1 \ O_2$

The observation of freshmen engineering students, O_1, relative to creativity and pre-cognition, were compared to the observation, O_2, of the creativity and pre-cognition of engineering seniors. The treatment X_1, is the engineering curriculum. O_1 and O_2 are not observations of the same group since there is a time factor of four years involved in the application of the treatment. However, the two groups can be related statistically.

The proposition of a significant difference between the two groups was tested via a Z statistic at 95% confidence. The test was a one tailed test since the hypothesis is directional in nature. (47)

Hypothesis 2) $O_3 \ X_2 \ O_4$

This test is identical to the test for Hypothesis 1 with the exception that the students were from liberal arts rather than engineering. The hypothesis anticipates an increase in the creative index of seniors as compared to freshmen students. Significance was tested via a one tailed Z test.

Hypothesis 3) $\frac{O_1 \ X_1}{O_3 \ X_2}$

Test three is a statistical comparison between the creativity of

engineering freshmen and liberal arts freshmen. The Z test, a 95% confidence, was two tailed since the hypothesis is non-directional.

Hypothesis 3A) $X_1 \quad O_2$

$X_2 \quad O_4$

The creativity of engineering seniors was compared to the creativity of liberal arts seniors. A single tailed Z test was used to statistically compare the means of the two groups.

Hypothesis 4) $X_1 \quad O_2$

O_5

A one tailed t test at 95% confidence was used to compare the creativity of engineering seniors to the creativity of engineering drop outs.

Hypothesis 5) $O_6 \quad O_7$

Creativity and pre-cognition scores were correlated using a Pearson linear correlation in an effort to establish a relationship. The hypothesis is non-directional and theoretically states that the correlation is zero.

RESULTS

CREATIVITY

A summary of the total creativity scores is given in Table 2.

Table 2 - Creativity Scores

Group	Mean	Standard Deviation
Engineering Freshmen	120.13	33.91
Engineering Seniors	120.50	36.35
Liberal Arts Freshmen	116.37	32.86
Liberal Arts Seniors	108.82	34.92

PRE-COGNITION

The number of correct digits, referred to as "hits", predicted by the four groups tested are presented on a per group basis in Table 3.

Table 3 - Pre-Cognition Scores

Group	Mean	Standard Deviation
Engineering Freshmen	9.63	2.84
Engineering Seniors	9.72	3.47
Liberal Arts Freshmen	9.73	3.01
Liberal Arts Seniors	9.69	2.50

TEST OF HYPOTHESES

The results of the data analysis that follows is divided into six sections, one section for each hypothesis.

Hypothesis 1:

The creativity of senior engineering students is lower than the creativity of engineering freshmen.

Since the sample size is statistically large, a Z statistic has been used to test the hypothesis. Also, the hypothesis is directional, therefore a single tail test has been used. (48) Acceptance of the hypothesis at a confidence of 95% requires a Z of 1.64 or higher.

The mean scores and standard deviations given in Table 2 produced a calculated Z of .0186 which will not support an acceptance of the hypothesis.

Hypothesis 2:

The creativity index of liberal arts freshmen is lower than the creativity index of liberal arts seniors.

This test is directional and requires a Z of 1.64, at 95% confidence, for acceptance.

Using the means and standard deviations in Table 2, the calculated Z is -.956, and the hypothesis is rejected.

Hypothesis 3:

The creativity index of engineering freshmen is the same as the creativity index of liberal arts freshmen.

The hypothesis is non-directional. A Z of $\pm$ 1.96 or larger is required for a rejection at 95% confidence. The calculated Z is .485 and the hypothesis is accepted.

Hypothesis 3A:

The creativity of liberal arts seniors is greater than the creativity of engineering seniors.

A directional test, to 95% confidence, has been used to test this hypothesis. A Z of 1.64 or higher is needed for acceptance. Calculations, using the data shown in Table 2, produced a Z of -1.424. The hypothesis is rejected.

Hypothesis 4:

Drop outs from the engineering program have a higher creativity index than engineering seniors.

There were not enough drop out students available to make up a reliable sample size. Data was taken on eleven students. The mean creativity score of the eleven students is 108.54, comparable to the mean creativity score of liberal arts seniors.

No attempt has been made to draw an inference relative to this hypothesis since the sample size is statistically insufficient.

Creativity Component Scores

The statistical tests used to resolve the hypothesis that deal with comparative creativity use the mean total creativity scores of the student groups, given in column S of the creativity data. (See appendix 1)

Total creativity is the sum of four components: fluency, flexibility, originality and elaboration. Figure 1 shows the comparative creativity scores for each student group relative to the four components of total creativity. Table 4 gives the mean score for each group relative to each component of creativity.

Table 4- Component Mean Creativity Scores

	1	2	3	4
Fluency	13.60	16.00	16.18	16.19
Flexibility	12.33	12.60	12.29	11.50
Originality	33.58	35.80	24.94	26.88
Elaboration	60.61	56.12	62.94	54.25

1) Engineering Freshmen
2) Engineering Seniors
3) Liberal Arts Freshmen
4) Liberal Arts Seniors

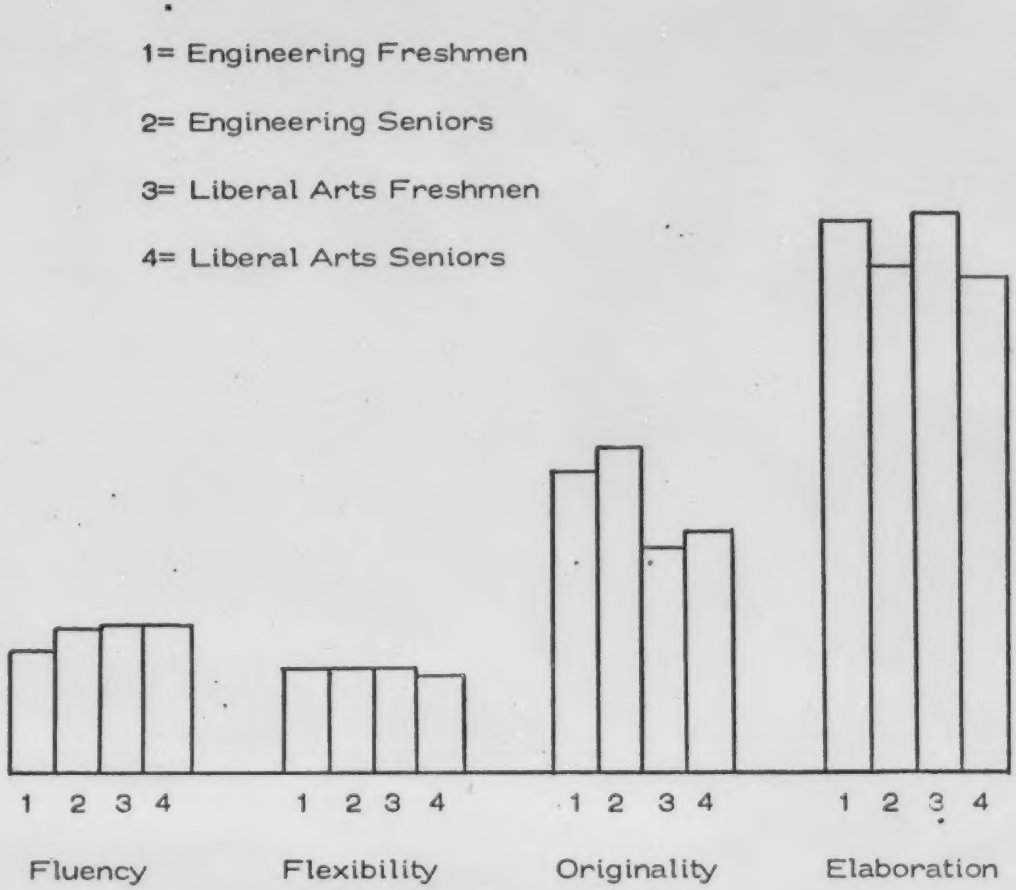

Figure 1 Component Creativity Scores

Hypothesis 5:

The pre-cognitive ability of students is an indicator of their creative ability.

The student's score on fluency, flexability, originality and elaboration are added to produce the student's total creativity score. There is a tendency for a high score, say in originality, to offset a low score on another component. Therefore, it will be necessary to relate pre-cognition scores to each component of total creativity. A Pearson correlation (r) was performed relating each component factor of creativity to pre-cognition.

Since there are over 3000 scores and 72 correlations involved in the analysis, a computer program was used to produce the correlations.

The correlations for each student group on a pre-cognition to creativity component basis, B through S (see appendix 1) is given in Tables 5 through 8. The significance of the correlations may be determined by a Z statistic for sample sizes over 30. (48)(Footnote 1)

Footnote 1: The statistic Z was calculated via: (49) $Z=r\sqrt{N-1}$

Table 5 - Correlation of Pre-Cognition to Component Creativity Scores B through S for Engineering Freshmen

Component	r	Z	Confidence, %
B	-.0138	-.0816	6.38
C	-.0917	-.5425	41.20
D	-.3028	-1.7913	92.66
E	-.2933	-1.7352	91.64
F	-.2832	-1.6754	90.60
G	-.2566	-1.5180	87.04
H	.0158	.0935	7.20
I	-.0303	-.1792	14.24
J	-.1749	-1.0347	69.80
K	.1416	.8377	59.60
L	-.1445	-.8548	60.70
M	-.1775	-1.0501	70.62
N	-.2235	-1.3222	81.36
O	-.0838	-.4957	37.80
P	-.0176	-.1041	8.20
Q	-.3027	-1.7908	92.56
R	-.0634	-.3751	29.10
S	-.1327	-.7851	56.70

Table 6 - Correlation of Pre-Cognition to Component Creativity Scores B through S for Engineering Seniors

Component	r	Z	Confidence, %
B	.0212	.1324	10.50
C	.1315	.8212	58.80
D	.2422	1.5125	86.96
E	.2545	1.5900	88.82
F	.0485	.3028	23.80
G	.1097	.6850	50.50
H	-.0521	-.3253	25.40
I	-.0085	-.0531	4.00
J	-.0160	-.0999	7.80
K	.1348	.8418	60.00
L	.0328	.2048	16.20
M	.1068	.6669	51.60
N	-.0011	-.0068	.40
O	.1338	.8355	59.50
P	.1371	.8562	60.72
Q	.1573	.9823	67.40
R	.0545	.3403	26.64
S	.0582	.3634	28.40

Table 7 - Correlation of Pre-Cognition to Component Creativity Scores B through S for Liberal Arts Freshmen

Component	r	Z	Confidence, %
B	-.2045	-1.2606	79.26
C	.1176	.7249	53.10
D	-.0062	-.0382	3.00
E	.1341	.8266	59.10
F	.1343	.8278	59.20
G	.1307	.8057	57.90
H	.1831	1.1287	73.90
I	.1278	.7878	56.84
J	.0752	-.4635	35.64
K	.0588	-.3624	28.32
L	.0540	.3328	26.06
M	.1568	.9667	66.50
N	.0086	.0530	4.38
O	.0096	.0592	4.60
P	.1381	.8513	60.66
Q	.0382	.2354	18.50
R	.2066	1.2736	79.70
S	.0140	.0863	6.70

Table 8 - Correlation of Pre-Cognition to Component Creativity Scores B through S for Liberal Arts Seniors

Component	r	Z	Confidence, %
B	.1220	.7217	53.24
C	-.3300	-1.9523	94.92
D	.1177	.6963	51.20
E	-.0565	-.3342	26.24
F	-.1253	-.7413	54.28
G	-.1977	-1.1696	75.70
H	-.0846	-.5000	19.15
I	-.0453	-.2679	21.00
J	-.2362	-1.3973	83.74
K	-.2776	-1.6433	89.96
L	-.0182	-.1076	8.56
M	-.0668	-.3952	30.60
N	-.2637	-1.5601	88.12
O	-.3281	-1.9411	94.78
P	-.2602	-1.5393	87.62
Q	-.1464	-.8661	61.24
R	-.2879	-1.7032	91.12
S	-.4259	-2.5196	98.80

Relationships approaching significance at reasonable confidence levels between pre-cognition and creativity developed for both engineering freshmen and liberal arts seniors in such a way that a pattern is produced.

Engineering freshmen showed higher correlations between pre-cognition and creativity on creativity indexes D, E, F. G and Q. Table 9 identifies the creativity indexes and gives the confidence of the proposition that a relationship exists.

Table 9 - Activity 2, Correlations - Engineering Freshmen

Creativity Index	Identification	Correlation Z	Confidence
D	Fluency-Activity 2	-1.7913	93%
E	Flexibility-Activity 2	-1.7352	92%
F	Originality-Activity 2	-1.6754	91%
G	Elaboration-Activity 2	-1.5180	87%
Q	Total Score-Activity 2	-1.7908	93%

All other correlations involve a possible decision error of 20% or more and are statistically unacceptable.

Data on liberal arts seniors also yielded near-significant or significant correlations between pre-cognition and creativity in such a way that a pattern is identified. Table 10 identifies the creativity indexes that correlated to pre-cognition, the Z statistic, and the confidence level.

Table 10 - Elaboration and Total Score Correlations - Liberal Arts Seniors

Creativity Index	Identification	Correlation Z	Confidence
C	Elaboration, Activity 1	-1.9523	95%
K	Elaboration, Activity 3	-1.6423	90%
O	Elaboration, Total Score	-1.9411	94%
R	Activity 3, Total Score	-1.7032	91%
S	Composite, Total Score	-2.5196	98%

The creativity of each student, on 18 components, has been correlated to the student's pre-cognitive score. Consequently, for each group, 18 correlations, one for each component of creativity, has been produced. Some of the correlations are statistically significant, others are not, but, as a group of 18 factors, they produce a pattern when plotted. The question that comes to mind is not one of significance alone, but also one of pattern. For example, one group may have several significant correlations among the 18, while another group may have none, but the pattern of correlations may be quite similar to the extent that the two patterns produce significant correlations. The significance of such a correlation indicates a common relationship between pre-cognition and creativity from group to group; only the

degree of correlation may differ within each group.

Therefore, a correlation of the correlations between groups was calculated. The absolute correlation of engineering freshmen correlations to engineering seniors' correlations came to .4647, and the correlation for engineering freshmen correlations to liberal arts freshmen correlations was .4472.

Since the sample size is under 30, a t test was used to test the factors for significance. The t calculation was based on the following:

$$t = r\sqrt{\frac{N-2}{1-r^2}}$$

The t value for the engineering freshmen to engineering seniors calculated to 2.101 which indicates a relationship of 96% confidence. The correlation of engineering freshmen to liberal arts freshmen produced a t of 2.0 which indicates a relationship to 93% confidence. Other group combinations did not produce significant relationships.

DISCUSSION

CREATIVITY

Four groups were tested and graded on creative potential. The mean creativity score for each group is listed below, from highest to lowest score.

Group	Mean Creativity Score
Engineering Seniors	120.50
Engineering Freshmen	120.14
Liberal Arts Freshmen	115.60
Liberal Arts Seniors	108.82

There is no significant difference, at 95% confidence, between the mean scores of the groups. However, if the confidence is lowered to 92%, a statistical difference occurs between the scores of engineering seniors and liberal arts seniors, with engineering seniors holding the significantly higher score.

Regardless of the creative ability of freshmen engineering and liberal arts students, it seems apparent that the graduating engineer has a higher creative ability than the graduating liberal arts student.

The cause of the difference in creativity between engineering graduates and liberal arts graduates has to do with originality, which may be the most significant component of creativity.

The student's creativity score is the sum of four components: fluency, flexibility, originality and elaboration. Engineering seniors and liberal arts seniors scored almost identically on three of the components; fluency, flexibility and elaboration. However, engineering seniors significantly outperformed liberal arts seniors on originality.

The statistical test for significance of difference between the originality of engineering and liberal arts seniors yielded a Z of 2.89 confirming the higher engineering score at a confidence of over 99%

However, the engineering freshman enters the engineering school at an originality level that is higher than the liberal arts freshman by an amount that is almost precisely equal to the difference between the originality level of the engineers and liberal arts students at graduation. The numerical differences between the originality of engineering and liberal arts freshmen is 8.64 points, while at graduation, the difference is 8.92 points.

It seems apparent that the superiority of the engineering student in originality was present before the effect of the engineering curriculum was applied. Engineering education seems to draw the more creative student.

The Torrance figural B test for creative ability involves drawings and designs rather than words. An argument may be presented to the effect that the nature of the test favors engineering students who are naturally inclined and schooled in expressing their ideas via drawings and sketches. Liberal arts students are oriented toward the expression of ideas via words.

The argument is not valid for two reasons. First, the liberal arts students performed on drawings as well as the engineering students on fluency, flexibility and elaboration. There was a significant difference only on originality. Table 11 gives the comparative scores of the engineering and liberal arts seniors.

Table 11 - Comparative Creativity Scores

Group	Fluency	Flexibility	Originality	Elaboration	Total
Eng. Seniors	16.00	12.60	35.80	56.12	120.50
L.A. Seniors	16.19	11.50	26.88	54.25	108.82

If the engineering students had an advantage, they may be expected to demonstrate the advantage via elaboration since the drawing ability of the engineer vs. the liberal arts student would be overpowering. This did not happen. If liberal arts seniors operated at a disadvantage,

they would be expected to show this disadvantage in areas of elaboration and fluency, but not on originality since the originality of the drawing does not depend on drawing ability.

Moreover, the Torrance system of creativity tests includes verbal tests. The Torrance figural test, which was used for this study, has been correlated to the Torrance verbal tests.

Torrance reported the correlations shown in Table 12. The correlations were performed on 229 sets of grades, all of which were taken on college under graduates. (50)

Table 12 - Correlations of Verbal to Figural Tests

Components	Correlation	Confidence
Fluency-Verbal to Figural	.30	Virtually, 100%
Flexibility-Verbal to Figural	.25	99.98%
Originality-Verbal to Figural	.34	Virtually, 100%

Here again, the support is in favor of the proposition that the engineers did not operate at an advantage in outperforming the liberal arts students on originality, since originality, verbal to figural, shows the strongest correlation. However, these correlations are, in fact, small. A correlation of .30 explains less than 10% of the common

variance.

The drop in the total mean creativity of liberal arts students from a freshman level of 116.35 to a senior level of 108.82 is due entirely to a loss of elaborative ability. Freshmen scored 62.94 on elaboration while the seniors scored only 54.25, a loss of 8.69 points. Engineering students, from freshmen to senior level, also dropped in elaborative ability, but the loss was only 4.49 points which was offset by slight gains on the remaining creativity components.

Relative to creativity, the most significant result of this research is the discovery that engineering students have a significantly higher creative ability than liberal arts students with regard to originality, which is perhaps the most important component of overall creativity.

The result does not coincide with the predictions of Guilford and others relative to the creative capacity of engineers. (2)

ENGINEERING DROP OUTS

Data taken on engineering freshmen and seniors indicate that the creative potential of the two groups is the same. It may be assumed that engineering drop outs leave engineering at the end of the freshman year. If so, the data taken on engineering freshmen includes the future drop outs. If the engineering drop outs hold the higher creative ability,

we may expect to see a lowering of the creative potential of engineering seniors. This did not take place, although it is possible that the effect shows up in the creative potential of engineering sophomores, as a group, but the subsequent engineering education pulls the creativity of the students upward. Additional research would be necessary to resolve this issue; however, there does not seem to be any evidence that the engineering education lowers creativity or causes the creative student to drop out, contrary to the predictions of some eminent educators.

CREATIVITY AND PRE-COGNITION

Pre-cognition is defined as an ability to see the future. Creativity has many definitions, but it is, in many cases, a present activity that tends to deal with the future. The creative ideas of today may be the reality of tomorrow. If these two characteristics or traits are related to the same thing, the future, we may expect to find correlations between test scores that measure the traits.

The attributes of weight and height of a person are relatively fixed measurements. If we measure today and again tomorrow, the measurements would be almost identical. However, pre-cognition and creativity are not like that. A person's pre-cognitive and creative ability at a particular time depends on environmental conditions, the

person's mental attitude, his pre-occupation, and undoubtedly, many other factors. Consequently, when we measure pre-cognition and creativity, we get a score that is from a distribution of many possible scores for that person who, presumably, has a fixed mean ability in each area. Therefore, sometimes we get a correlation between pre-cognition and creativity, and sometimes we don't. The laboratory conditions and the control of variables necessary to obtain true test data is unknown.

On a series of tests that relate pre-cognition to creativity, the absense of a significant correlation is not conclusive. Also, a single or random assortment of significant correlations may prove little, if anything. However, if significant correlations develop in selective patterns, there may be a strong indication that the relationship is not one caused by chance alone.

Consider the data produced by this study that relates the pre-cognition and creativity of engineering freshmen. Freshmen engineers produced significant correlations between pre-cognition and creativity in 5 out of 18 possible categories, and the correlations are significant at least at 87% confidence. Correlations did not develop for any other portions of the creativity test. The 5 categories of creativity that correlated well with pre-cognition are the 5 parts of activity 2.

If we make the assumption that significant correlations between pre-cognition and creativity may or may not occur by chance alone, and assume that the probability of a significant correlation is .5, then what is the probability that this chance relationship will isolate itself to activity 2, all 5 parts of activity 2, and to none of the other 13 categories of creativity? This proposition involves position and selection since activity 2 represents 5 distinct locations in the list of 18 components that make up the creativity measurements. Therefore, chance alone would have to select 5 specific items, and no others, out of the list of 18 items. The chance selection of all 5 items that make up activity 2 represents a one shot selection.

The probability that such an event would occur, by chance alone, is one in 8500, a most unlikely event.

Engineering freshmen and liberal arts seniors consistently produced negative correlation of pre-cognition to creativity while engineering seniors and liberal arts freshmen consistently produced positive correlations.

Engineering freshmen scored 2 positive and 16 negative correlations. The probability of 2 out of 18 correlations going negative, if negative and positive correlations are equally likely, is .0005, or one chance in 2000.

The same correlation drift was evident for liberal arts freshmen and engineering seniors, but it was not as pronounced. The probability of 4 out of 18 correlations going negative on a chance basis is one in 86.

A very strong correlation exists between pre-cognition and total creativity for liberal arts seniors. The correlation of -.4259 corresponds to a confidence of nearly 99 percent, which leaves only one chance in 100 that the relationship is due to chance alone.

It is interesting to note that every significant correlation of pre-cognition to creativity was negative. As scores on one variable increased, scores on the other decreased. The outcome differed from the prediction of this study that proposed a similarity between an ability to foresee the future and creative ability, that is, a positive relationship.

The cause of the negative relationship is unknown.

Another interesting, but unexplainable phenomenon, is the proposition that engineering freshmen's correlations, almost all negative, and engineering senior's correlations, almost all positive, when viewed in the absolute and correlated against each other, produce a pattern that is related at a 96% confidence level. Each group's reactions, as indicated by individual pre-cognition scores, to the 18 components of

creativity, were the same.

Under the circumstances, we may disregard the individual correlations of pre-cognition to the 18 components of creativity, and instead, look at the pattern. Patterns may be common among certain types of groups, as they are common for engineering freshmen and seniors. If such patterns can be predicted, a combined pre-cognition and creativity test may indicate the "type" of the subject; whether he is engineering oriented or business oriented, etc. Further research in this area may be warranted.

CONCLUSIONS

1) Engineering freshmen and seniors at the University of New Haven possess a significantly higher creative potential in the area of originality, than freshmen and seniors in the University's liberal arts programs.

2) This study has produced some strong indications that creativity and pre-cognition are related.

Engineering students had a tendency to show a relation between creativity and pre-cognition on activity 2 of the Torrance test. Liberal arts seniors showed correlations on the elaboration portions of the Torrance test, as well as a strong correlation on the total creativity index score.

3) Engineering freshmen and liberal arts seniors consistently yielded negative correlations between pre-cognition and creativity. Engineering seniors and liberal arts freshmen did the opposite; they tended to produce positive correlations.

The cause of correlation drift in groups is unknown. However, Mihalasky has discussed the Rao effect where a group involved in the

performance of two extra-sensory tests has the tendency to do better than chance on one and lower than chance on the other. (27) There may be a reverse image effect in operation that is similar to the Rao effect. (51)

4) The most striking conclusion that must be drawn from the results of this investigation is that the four years of college, experienced by students at the University of New Haven, did nothing toward increasing and in fact, decreased the student's creative propensity.

RECOMMENDATIONS

CREATIVITY

An examination of the freshmen and senior scores on the four components of creativity, Table 4, page 39 , led to the conclusion that the college experience has little effect on the creative performance of students. At least this is true for the students who were tested at the University of New Haven.

The results indicate that the students have been taught "subjects" but have not been taught how to create. The facts of the subject matter are conveyed to the student, and the repetition of these facts by the student results in successful progression toward the degree.

However, the students have not been taught to perform creatively; there has apparently been little or no training of this capacity.

Teachers consume entire semesters of classroom time in conveying information to the students when the bulk of the information can be readily found in the text specified for the course. The classroom has become a session where the teacher "reads" the text to the students. The students expect to be given information by the teacher. The University has become an animated encyclopedia rather than a center for the development and training of the mind. Progress is apparently not our most important product.

The recommendation is not a series of specifics, or modification of teaching methods; instead, the recommendation is general in nature and involves the development of new courses, the details of which may best be determined by specialists in the area of philosophy and psychology. These new courses would teach thinking creatively.

Logical thinking is apparently stimulated in students via the transfer of information. Logical thinking involves the most probable interpretation, the interpretation that produces the most common response by the student. Many times, the sequence of logical thinking, including the desired and common response, is taught by the teacher; stimuli, followed by an acceptable response that is predetermined as the correct response.

Computers are "programmed" to accept certain stimuli, and produce a predetermined response. The computer can store millions of bits of information, never makes an error (programers make errors), never forgets, and seldom fails to respond to a given stimuli. The computer is superior to man relative to straight line logical thinking. However, the computer is incapable of critical judgment.

Lateral thinking is a different matter. It is disruptive in nature. Lateral thinking comprehends accepted concepts, but immediately

explores new concepts in response to new information or new observations, often abandoning old concepts.

DeBono of Cambridge put it this way: "It is not possible to dig a hole in a new place by digging the same hole deeper. Logic is the tool that is used to dig the same hole deeper and bigger to make them altogether better holes. But if the hole is in the wrong place, no amount of improvement is going to put it in the right place. Vertical thinking is digging the same hole deeper, lateral thinking is trying again in a different place." (1)

The higher educational process should concentrate on the development of lateral thinking.

On the practical side, the creative process may be improved significantly by concentrating on the four components of creativity; fluency, flexibility, originality and elaboration.

1) The term project or report system is seldom used by teachers at the University of New Haven. The practice of requireing a term paper should be revived. Students should write term papers, not for the teacher to read, but for others who are not familiar with the course material. Consequently, fluency and elaboration would be a necessary characteristic of the paper.

2) Homework assignments should present problems in such a way as to give the student alternatives relative to the solution of the problem.

In engineering work, for example, the homework assignment is to design a "Warren truss" that will take certain dynamic loads over a certain span. It would be better to ask the student to design a "system" that will take the load over a certain span. The latter approach offers the student a choice as to the method he may employ. The student's flexibility and originality would be exercised by the "systems" approach, but not by the specific instruction to use a "Warren truss".

3) There seems to be a tendency, relative to homework assignments, to accept the homework as it is and then give a grade. If the work is good, complete and accurate, the grade is A. On the other hand, if the work is incomplete, sloppy, inaccurate, the grade is D.

The process should ignore the opportunity of grading the student. Instead, poor work should be returned with instructions to do it over. In the process, the student may be taught to give initial consideration to fluency and elaboration.

4) Classroom projects could start at the point where a text book solution stops. For example, the teacher may design a system according to the existing principles and accepted ways of doing things.

The design would be complete. However, the assignment would be to find a better way, or at least a different way.

This technique would demand an original response by the student, and risk on the part of the teacher's sense of security.

The four suggestions represent teaching strategies and techniques. Without doubt, there are many more devices that may be employed to enhance the creative process in students. Some techniques would be useful in some areas, but not in others. Expertise in the subject matter is rather essential to the design of strategy that will improve the creative potential of students.

Therefore, the recommendations directed toward the University of New Haven are:

1) Prepare a policy commitment that directs the faculty and student body toward the development of a creative university.

2) Create a student-faculty steering committee that will direct and assess the implementation of the policy via participation by representatives of academic departments.

3) Audit the results of implemented procedures by testing.

The recommendations are broad, but contain the essential element

of success: a university-wide commitment to improve the creative energy of its students and faculty.

PRE-COGNITION

Results of this study, in the attempt to relate pre-cognition to creativity, are interesting from several standpoints.

Correlation drift from positive to negative relative to different groups indicate that forces are at work other than chance alone. Strong positive or negative correlations of pre-cognition to certain parts of the Torrance creativity test would indicate little except for the fact that the parts of the Torrance test that correlated were themselves related.

The probability of chance relationships are too low to ignore. Creativity and pre-cognition are related, but there are other variables involved that cannot be clearly identified. On one of his experiments with pre-cognition, Dean noticed a shift in pre-cognitive ability with the presence or absence of stress in the subjects. Stress reduced pre-cognition ability. (27)

Recently, the writer tested a small group for pre-cognitive ability. One person in the group had only 6 hits in 100 tries. After the test, the group relaxed and had coffee and informally discussed the pre-cognitive phenomenon. The person with the low score of 6 asked to

try again. This time the score was 14. We know that a relaxed subject performs better.

It may be possible to reduce the effect of stress on the subjects at the time of testing via psychological suggestion. Also, highly stressed subjects might be identified and their test data isolated in a "high stress" group. Medical examination of blood pressure, pulse rate, temperature and eye motion might isolate the high stressed subject.

Highly controlled experiments may be necessary before consistent results are experienced. Also, the subjects should work with the investigator over a long period of time. Repeated measurements under various test conditions, using the same test group may identify the unknown factors that reduce or enhance the relationship between pre-cognition and creativity.

Study in the area of pre-cognition and creativity is increasing. The role of intuitiveness in decision making is well recognized today, but not well understood as to its mechanism. There will be research in the future that will describe the apparently complex relations between the mind and future events, and the phenomenon of creativity.

REFERENCES

1) DeBono, E. Cambridge University, The Use of Lateral Thinking
London: Cape 1970

2) Guilford, Intelligence, Creativity and Educational Implications
1968

3) Kagan, J. Creativity and Learning
Boston: Houghton and Mifflin, 1967

4) Schofer, R. Assessment of Human Motives
New York: Rinehart 1958

5) Storr, A. The Dynamics of Creation
New York: Rinehart 1958

6) Rogers, C. R. Theory of Creativity
New York: Harper 1959

7) Bowers, P. G. Effect of Hypnosis on Creativity Test Performance
Journal of Personality, 1967

8) Roe, A. A Psychological Study of Emminent Biologists
Psychological Monograph, 64, #14, 1951

9) Roe, A. The Making of a Scientist
New York: Dodd-Mead, 1952

10) Torrance, E. P. Creativity - Its Educational Implications
New York: Wiley 1967

11) Domino, G. Maternal Personality Correlation of Son's Creativity
Journal of Consulting and Clinical Psychology, 33, 1969

12) Gruber, Terrell, Wertheimer (editors) Contemporary Approaches to Creative Thinking
New York: Athereum, 1964

13) Gilford, J. P. A Psychometric Approach to Creativity
California: Science and Behavior, 1965

14) Gilford, J. P. The Nature of Human Intelligence
New York: McGraw Hill, 1967

15) Butcher, H. J. Human Intelligence, Its Nature and Assessment
London: Methuen, 1968

16) Gilford, J. P. Creativity and Educational Implications
San Diego: Knapp 1968

17) Getzel, J. W. and Jackson, P. W. Creativity and Intelligence
New York: Wiley, 1962

18) Marsh, R. W. A Re-Analysis of Getzel's Data
British Journal of Educational Psychology, 34-91-1964

19) Edwards and Tyler, Intelligence, Creativity and Achievement
Journal of Educational Psychology 56, 96, 1965

20) Torrance, E. P. Educational Achievement and the Highly Intelligent
Minneapolis: University of Minnesota Press, 1960

21) Cline, Richards and Abe Validity for a Battery of Creativity Tests
Educational and Psychological Measurement, 22, 1962

22) Stollings and Gillmore Relations Between Figural Creativity and Grades in a College of Fine and Applied Arts
University of Illinois, ERIC ED062924, 1972

23) Follman, J. Multivariate Analysis of the Relationship Between Creativity and Intelligence
New Orleans: American Educational Research Association, 1973, ERIC ED076684

24) Yamamoto, K. Effect of Range and Test Unreliability on Correlations Between Creativity and Intelligence
British Journal of Educational Psychology 35, 300, 1965

25) Freeman, McComisky, Buttle Research Into Divergent and Convergent Thinking
Journal of Electrical Engineering Education 6, 99, 1968

26) Snyder, B. Creative Students in Science and Engineering
University Quarterly 21(2) 1967

27) Dean, D. and Mihalasky, J. Executive ESP
Prentice Hall, 1974

28) Barron, F. and Kantor, R. The Affective Domain and Beyond
Journal for the Study of Consciousness Jan.-June 1970

29) Schmeidler, G. Pre-Cognition Related to Creativity
Journal of Parapsychology V 28, 1964

30) Honorton, C. Creativity and Pre-Cognitive Scoring Level
Journal of Parapsychology 31, 1967

31) Torrance, E. P. Norms-Technical Manual, Torrance Tests for Creative Thinking
Personnel Press, 1973

32) Kubie, L. S. Unsolved Problems of Scientific Education
The Journal of the American Academy of Science, Summer, 1965

33) Heist and Wilson Curricular Experiences for the Creative
San Francisco: Jossey Boss, 1968

34) MacKinnon, D. W. Fostering Creativity in Engineering Students
Journal of Engineering Education, 52, 1961

35) Simons, J. H. Scientific Research in the University
American Scientist, 48, 1960

36) Thorndike, R. L. The Measurement of Creativity
Teachers College Record, 64, 1963

37) Henle, M. The Birth and Death of Ideas
Contemporary Approaches to Creative Thinking, edited by Henry, W. E., Atherton Press 1964

38) Costello, F. J. Evaluation of the Socialtal Policy of an Urban University
ERIC ED 131784

39) Woodthe, K. H. A Study of the Reliability of Creativity Tests
Doctoral Dissertation, University of Utah, 1963

40) Goralski, P. S. Creativity: Approaches to Classroom Teaching
Doctoral Dissertation, University of Minnesota, 1964

41) Hagender, H. Influence of Creative Writing on Creative Development
Master's Thesis, University of Minnesota, 1967

42) Fleming and Weinbraub Rigidity as a Measure of Creativity
Journal of Educational Psychology 53, 1962

43) Yamamoto, K. Creative Writing and School Achievement
School and Society, 91, 1963

44) Dean, D. Pre-Cognition - Clairvoyance
Journal of Parapsychology 34-12/ 1970

45) Osis, K. Pre-Cognition Over Time Intervals
Journal of Parapsychology 19-1955

46) Schmeidler, G. An Experiment on Pre-Cognitive Clairvoyance
Journal of Parapsychology, 28 - 3 - 1964

47) Dixon and Massey Statistical Analysis
McGraw Hill, 1969

48) Manson, R. D. Statistical Techniques
Irwin, 1974

49) Bruning and Kintz Computational Handbook of Statistics
Scott-Foresman, 1968

50) Halpin, W. G. Department of Educational Psychology,
University of Montana

51) Rao, A. On Extra Sensory Testing
Journal of Parapsychology, Vol. 26, 1965

APPENDIX

APPENDIX 1

CREATIVITY DATA

Creativity data on each group is recorded via 18 columns of data. Each column, labeled B through S, represents the individual student's creativity scores relative to the following index of test activities:

Column	Identification	Description
B	Activity 1	Originality
C	Activity 1	Elaboration
D	Activity 2	Fluency
E	Activity 2	Flexibility
F	Activity 2	Originality
G	Activity 2	Elaboration
H	Activity 3	Fluency
I	Activity 3	Flexibility
J	Activity 3	Originality
K	Activity 3	Elaboration
L	Total Score	Fluency
M	Total Score	Flexibility
N	Total Score	Originality
O	Total Score	Elaboration
P	Total Score	Activity 1
Q	Total Score	Activity 2
R	Total Score	Activity 3
S	Total Score	Activity 1 + 2 + 3

B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	Student No.
4	5	6	4	8	23	3	1	40	17	9	5	52	45	9	41	61	111	1
3	17	10	10	14	37	7	5	28	4	17	15	45	58	20	71	44	135	2
3	9	9	9	12	30	7	7	8	18	16	16	23	57	12	60	40	112	3
2	9	10	10	16	43	4	4	51	17	14	14	69	69	11	79	76	166	4
4	7	5	5	4	20	5	3	2	7	10	8	10	34	11	34	17	62	5
0	15	6	5	5	19	5	4	14	15	11	9	19	49	15	35	38	88	6
3	7	3	3	4	12	6	6	8	13	9	9	15	32	10	22	33	65	7
3	19	9	9	12	33	8	5	29	21	17	14	44	73	22	63	63	148	8
2	4	9	9	11	20	15	15	15	20	24	24	28	44	6	49	65	120	9
5	19	10	9	8	37	3	3	36	24	13	12	49	80	24	64	66	154	10
5	26	10	10	17	59	11	6	10	36	21	16	32	121	31	96	63	190	11
4	11	4	3	4	23	6	5	11	8	10	8	19	42	15	34	30	79	12
5	10	9	9	11	23	3	3	18	11	12	12	34	44	15	52	35	102	13
0	4	4	4	6	27	1	1	23	21	5	5	29	52	4	41	46	91	14
1	7	7	7	4	13	4	4	7	20	11	11	12	40	8	31	35	74	15
5	19	4	4	3	28	4	4	19	30	8	8	27	77	24	39	57	120	16
0	9	6	6	8	31	7	7	12	40	13	13	20	90	19	51	66	136	17
4	13	10	10	14	44	10	10	32	24	20	20	50	81	17	78	76	171	18
0	14	3	3	4	7	8	7	5	18	11	10	9	39	14	17	38	69	19
4	25	5	5	6	24	10	8	38	27	15	13	48	76	29	40	83	152	20
0	8	5	4	5	33	2	2	35	12	7	6	40	53	8	47	51	106	21
5	8	6	5	8	26	14	12	37	24	20	17	40	58	13	45	87	135	22
4	10	10	7	14	32	5	5	41	10	15	12	59	52	14	63	61	138	23
3	16	5	5	6	37	10	9	14	21	15	14	23	74	19	53	54	126	24
3	10	10	9	16	31	5	2	49	10	15	11	68	51	13	66	66	145	25
4	12	6	6	9	27	8	7	25	36	14	13	38	75	16	48	76	140	26
1	17	7	7	7	31	3	3	1	15	10	10	9	63	18	52	22	92	27
4	14	8	8	9	18	2	2	36	2	10	10	49	34	18	43	42	103	28
3	8	7	6	6	16	6	5	13	29	13	11	22	53	11	35	53	99	29
0	7	10	9	11	26	7	5	26	23	17	14	37	56	7	56	61	124	30
5	26	7	7	10	27	7	6	22	27	13	13	37	80	31	51	62	143	31
5	14	5	5	3	9	4	4	5	12	9	9	13	35	19	22	25	66	32
5	8	9	9	14	57	15	15	20	35	24	24	29	100	13	89	85	187	33
5	9	5	4	6	27	6	6	12	29	11	10	23	65	14	42	53	109	34
5	12	6	6	7	25	11	10	10	29	17	16	22	66	17	44	60	121	35
3	12	8	8	13	31	6	4	40	21	14	12	56	64	15	60	71	146	36

Creativity - Engineering Freshmen

B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	Student No.
5	8	10	10	11	27	7	4	29	10	17	14	45	45	13	58	50	121	1
4	11	2	1	4	9	2	1	23	2	4	2	31	22	15	16	28	59	2
4	7	10	9	16	24	2	2	36	7	12	11	56	38	11	59	47	117	3
2	8	10	9	12	23	4	3	24	13	14	12	38	44	10	54	44	108	4
5	4	9	6	9	11	2	2	1	6	11	8	15	21	9	35	11	55	5
5	14	10	5	16	41	8	5	52	24	18	10	73	79	19	72	89	180	6
2	11	10	9	17	33	11	11	23	32	21	20	42	76	13	69	77	159	7
2	24	10	9	11	91	3	3	30	25	13	12	41	140	26	121	61	206	8
2	10	10	9	13	39	1	1	20	4	11	10	35	53	12	71	26	109	9
0	1	7	6	6	22	2	2	36	13	9	8	42	36	1	41	53	95	10
5	6	10	9	18	42	4	4	6	16	14	13	29	64	11	79	30	120	11
5	3	10	9	11	27	2	1	30	5	12	10	46	35	8	57	38	103	12
0	2	8	6	8	21	9	8	35	18	17	14	43	41	2	43	70	115	13
5	2	8	4	3	17	8	6	19	12	16	10	27	31	7	32	45	84	14
0	2	10	9	13	39	17	7	37	20	27	16	50	61	2	71	81	154	15
0	21	6	6	5	22	8	6	9	29	14	12	14	72	21	39	52	112	16
5	4	8	4	5	30	15	4	8	29	23	8	18	63	9	47	56	112	17
2	34	8	4	10	45	4	3	42	51	12	7	54	130	36	67	100	203	18
4	12	8	6	[illegible]	34	6	5	39	30	14	11	50	64	16	55	80	139	19
3	1	8	6	9	21	7	5	42	23	15	11	54	45	4	44	77	125	20
2	18	10	10	10	35	14	14	16	50	24	24	28	103	20	65	94	179	21
5	8	4	4	4	20	2	1	12	26	6	5	21	54	13	32	41	86	22
4	2	8	7	8	38	6	6	10	21	14	13	22	61	6	61	43	110	23
3	19	5	5	5	50	10	10	14	22	15	15	22	91	22	65	56	143	24
3	12	6	6	12	16	3	3	28	18	9	9	43	46	15	40	52	107	25
5	15	10	10	13	38	13	12	17	28	23	22	35	81	20	71	70	161	26
3	13	10	7	16	40	11	10	4	41	21	17	23	94	16	73	66	155	27
5	2	9	5	7	14	12	12	19	20	21	17	31	38	7	35	63	105	28
0	0	9	9	13	13	2	2	33	2	11	11	46	15	0	44	39	83	29
5	1	9	6	18	18	7	1	0	9	16	7	23	28	6	51	17	74	30
5	11	9	6	11	24	5	5	12	10	14	11	28	45	16	50	32	98	31
3	10	6	6	6	10	2	2	35	4	8	8	44	24	13	28	43	84	32
2	7	8	8	11	18	6	6	6	11	14	14	19	36	9	45	29	83	33
3	8	10	8	14	54	16	8	15	37	26	16	32	99	11	86	76	173	34
0	6	10	10	15	29	11	9	8	32	21	19	23	67	6	64	60	130	35
3	7	10	10	8	23	13	9	7	8	23	19	18	38	10	51	37	98	36
1	2	10	10	14	38	15	14	12	32	25	24	27	72	3	72	73	148	37
5	6	10	9	20	17	16	2	1	10	26	11	26	33	11	56	29	96	38
4	6	10	9	12	22	2	2	33	13	12	11	49	41	10	53	50	113	39
0	0	10	10	14	13	5	2	35	8	15	12	69	21	0	47	70	117	40

Creativity - Engineering Seniors

B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	Student No.
3	8	3	2	3	37	8	7	12	32	11	9	18	77	11	45	59	115	1
2	6	10	9	9	30	13	8	11	26	23	17	22	62	8	58	58	124	2
5	10	6	5	10	34	4	2	19	33	10	7	34	77	15	55	58	128	3
0	28	10	8	11	60	6	5	31	35	16	13	42	123	28	89	77	194	4
0	7	9	9	11	43	3	3	14	10	12	12	25	60	7	72	30	105	5
2	16	5	5	6	21	15	11	31	37	20	16	39	74	18	37	94	149	6
4	11	10	8	5	23	13	9	11	12	23	17	20	46	15	46	45	106	7
0	6	10	8	9	13	8	4	20	30	18	12	29	49	6	40	62	108	8
5	13	10	9	14	37	16	3	10	20	26	12	29	70	18	70	49	137	9
5	4	9	8	11	31	11	8	17	16	20	16	33	51	9	59	52	120	10
3	5	9	9	14	18	5	5	3	9	14	14	20	32	8	50	22	80	11
5	8	5	5	4	20	3	3	5	6	8	8	14	34	13	34	17	64	12
0	12	8	6	2	33	12	4	15	33	20	10	17	78	12	49	64	125	13
5	17	4	4	6	44	3	3	5	36	7	7	16	97	22	58	47	127	14
5	10	6	6	5	33	6	4	6	20	12	10	16	63	15	50	36	101	15
4	10	10	9	16	37	3	2	46	14	13	11	66	61	14	72	65	151	16
3	6	5	4	3	33	8	4	19	28	13	8	25	67	9	45	59	113	17
0	0	10	4	5	10	4	4	0	8	14	8	5	18	0	29	16	45	18
4	6	10	10	17	54	4	4	0	7	14	14	21	67	10	91	15	116	19
2	28	6	5	7	46	2	2	20	19	8	7	29	93	30	64	43	137	20
0	4	10	10	13	33	17	15	35	57	27	25	48	94	4	66	124	194	21
0	4	7	5	6	14	7	3	0	16	14	8	6	34	4	32	26	62	22
0	21	7	6	7	28	10	10	8	26	17	16	15	75	21	48	54	123	23
2	15	10	9	18	71	7	2	0	10	17	11	20	96	17	108	19	144	24
0	14	6	6	9	31	4	4	31	30	10	10	40	75	14	52	69	135	25
5	11	10	8	17	31	5	5	40	23	15	13	62	65	16	66	73	155	26
0	5	10	9	7	17	3	3	2	10	13	12	9	32	5	43	18	66	27
0	10	10	8	10	20	12	10	9	26	22	18	19	56	10	48	57	115	28
3	8	4	4	3	28	6	6	18	32	19	10	24	68	11	3[illegible]	52	112	29
0	10	10	7	5	33	17	9	4	31	27	16	9	74	10	[illegible]	51	126	30
5	16	8	6	9	42	2	1	0	7	10	7	14	65	21	6[illegible]	10	96	31
0	0	8	6	6	35	9	8	24	21	17	14	30	56	0	5[illegible]	62	117	32
5	6	10	9	15	38	15	3	6	12	25	12	26	56	11	72	36	119	33
4	7	7	6	10	22	4	4	4	8	11	10	18	37	11	45	20	76	34
3	8	10	10	12	25	21	9	12	29	31	19	27	62	11	57	71	139	35
0	12	8	8	9	24	6	5	17	22	14	13	26	58	12	49	50	111	36
2	9	5	4	2	30	14	12	13	37	19	16	17	76	11	41	76	128	37
1	6	6	6	7	3	8	3	10	5	14	9	18	14	7	22	20	55	38

Creativity - Liberal Arts Freshmen

B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	Student No.
5	8	8	7	9	42	0	0	0	0	8	7	14	50	13	66	0	79	1
5	7	9	8	7	28	6	5	15	29	15	13	27	64	12	52	55	119	2
5	16	5	5	6	8	14	3	32	14	19	8	43	38	21	24	63	108	3
5	4	10	8	12	37	14	7	0	8	24	15	17	49	9	67	29	105	4
4	17	7	6	13	43	5	3	33	33	12	9	50	93	21	69	74	164	5
2	16	9	7	11	39	17	17	9	57	26	24	22	112	18	66	100	184	6
5	12	10	10	13	42	10	8	8	34	20	18	26	88	17	75	60	152	7
2	2	9	4	9	18	8	2	2	12	17	6	13	32	4	40	24	68	8
5	4	10	1	10	25	2	2	36	8	12	3	51	37	9	46	48	103	9
5	15	3	3	6	24	15	14	27	23	18	17	38	62	20	36	79	135	10
5	13	6	3	6	14	9	2	20	20	15	5	31	47	18	29	51	98	11
2	13	8	3	5	25	2	2	5	8	10	5	12	46	15	41	17	73	12
4	5	4	3	5	23	6	1	0	14	10	4	9	42	9	35	21	65	13
5	9	6	5	8	26	16	8	28	24	22	13	41	59	14	45	76	135	14
0	2	10	9	15	35	5	5	8	21	15	14	23	58	2	69	39	110	15
3	14	6	6	8	29	9	5	9	19	15	11	20	62	17	49	42	108	16
5	14	10	7	7	19	12	10	24	15	22	17	36	48	19	43	61	123	17
3	6	10	10	4	22	11	4	9	31	21	14	6	59	9	46	55	100	18
0	19	10	9	11	34	1	1	2	3	11	10	13	56	19	64	7	90	19
2	16	10	10	15	28	13	5	24	30	23	15	41	74	18	63	72	153	20
3	10	10	10	13	43	14	10	14	51	24	20	30	104	13	76	89	178	21
3	2	4	4	6	17	2	1	30	10	6	5	39	29	5	31	43	79	22
0	0	10	5	7	1	3	3	13	6	13	8	20	7	0	23	25	48	23
2	10	10	10	16	56	4	3	25	29	14	13	43	95	12	92	61	165	24
0	8	10	7	8	19	12	10	16	22	22	17	24	49	8	44	60	112	25
0	17	3	2	4	20	8	8	27	25	11	10	31	62	17	29	68	114	26
2	5	10	9	11	32	13	3	20	25	23	12	33	62	7	62	61	130	27
4	17	8	8	11	23	5	2	9	13	13	10	24	53	21	50	29	100	28
0	4	3	3	2	8	4	2	0	9	7	5	2	21	4	16	15	.	29
0	7	9	9	9	20	11	11	17	19	20	20	26	46	7	47	58	11.	30
4	2	8	7	6	12	4	1	10	8	12	8	20	22	6	33	23	62	31
5	12	4	2	2	17	10	10	11	30	14	12	18	59	17	25	61	103	32
3	10	4	4	3	12	5	5	23	4	9	9	29	26	13	23	37	73	33
2	5	10	4	9	20	11	9	32	8	21	13	43	33	7	43	60	110	34
2	4	9	5	12	26	7	6	22	15	16	11	36	45	6	52	50	108	35
2	7	10	8	7	29	13	5	8	28	23	13	17	64	9	54	54	117	36

Creativity - Liberal Arts Seniors

B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	Student No.
4	10	10	11	11	42	2	2	10	10	12	12	25	62	14	73	24	111	1
5	4	10	10	14	28	12	12	19	33	22	22	38	65	9	62	76	147	2
4	7	7	6	9	10	16	13	7	26	23	19	20	43	11	32	62	105	3
5	6	10	9	12	24	7	7	20	14	17	16	37	44	11	55	48	114	4
3	9	10	9	10	34	18	12	10	27	28	21	23	70	12	63	67	142	5
5	4	10	8	12	21	7	6	27	9	17	14	44	34	9	51	49	109	6
5	7	7	7	6	33	10	7	10	22	17	14	21	62	12	53	49	114	7
4	13	7	7	8	18	3	3	24	4	10	10	36	35	17	40	34	91	8
4	6	8	8	15	20	8	8	14	16	16	16	33	42	10	41	46	97	9
5	5	7	6	6	14	7	5	48	10	14	11	59	29	10	33	70	113	10
0	1	6	3	2	11	5	4	5	14	11	7	7	26	1	22	28	51	11

Creativity - Engineering Drop Outs

APPENDIX 2

PRE-COGNITION SCORES

The lists on the following two pages contain the pre-cognition data for each group.

Student No.	HITS
1	12
2	9
3	6
4	5
5	10
6	9
7	10
8	11
9	7
10	9
11	10
12	14
13	5
14	9
15	15
16	9
17	14
18	11
19	10
20	6
21	9
22	11
23	8
24	8
25	7
26	11
27	4
28	8
29	8
30	11
31	11
32	14
33	8
34	8
35	12
36	15

Pre-Cognition-Engineering Freshmen

Student No.	HITS
1	15
2	8
3	7
4	12
5	14
6	8
7	15
8	11
9	13
10	8
11	6
12	7
13	7
14	7
15	6
16	7
17	12
18	10
19	15
20	7
21	17
22	12
23	9
24	8
25	4
26	10
27	5
28	4
29	10
30	9
31	17
32	5
33	10
34	11
35	11
36	8
37	9
38	8
39	13
40	14

Pre-Cognition-Engineering Seniors

Student No.	HITS
1	8
2	11
3	10
4	7
5	10
6	6
7	11
8	9
9	16
10	6
11	6
12	9
13	11
14	11
15	15
16	9
17	5
18	13
19	8
20	15
21	15
22	10
23	8
24	13
25	10
26	8
27	9
28	8
29	11
30	5
31	7
32	12
33	12
34	12
35	14
36	6
37	8
38	6

Pre-Cognition-Liberal Arts
Freshmen

Student No.	HITS
1	9
2	9
3	8
4	13
5	7
6	8
7	10
8	10
9	10
10	14
11	9
12	12
13	10
14	8
15	15
16	9
17	11
18	14
19	11
20	10
21	6
22	11
23	11
24	6
25	10
26	6
27	8
28	7
29	8
30	6
31	15
32	12
33	7
34	11
35	10
36	8

Pre-Cognition-Liberal Arts
Seniors